CubeSat with Nanostructured Sensing Instrumentation for Planetary Exploration

Completed Technology Project (2015 - 2016)

Project Introduction

The University of Southern California and University of Utah propose an innovative concept study to develop a CubeSat integrated with a new, nanosensor based instrument for low cost in situ analysis of asteroid and comet composition. The new instrument utilizes a TiO2 nanotube sensing platform with integrated compound semiconductor nanowires to determine surface composition element via Neutron Activated Analysis (NAA). This technique requires no sample preparation and collection operation, and is able to detect over 74 trace elements in parts per billion (ppb) range. The instrument is low cost, low power, low mass, compact, and disposable, thus making it potentially useful for integration with a CubeSat. This research will investigate the feasibility of an innovative, low cost, CubeSat based planetary mission concept which applies the proposed instrument for in situ ground truth analysis of small asteroids and comets.

Anticipated Benefits

NASA's planetary science objective is to advance scientific knowledge of the origin and history of the solar system, the potential for life, and the hazards and resources present as humans explore space. Surface composition analysis is a top science priority of NASA's planetary science program. For instance, the planetary science decadal survey lists Comet Surface Sample Return and Lunar South Pole-Aitken Basin Sample Return as high priority medium class missions, and Mars Astrobiology Explorer as a high priority large class mission. One of the scientific objectives of the Comet and Lunar Sample return missions is to characterize the surface region sampled. One of the scientific objectives of the Mars Astrobiology Explorer mission is to perform in situ science on Mars samples to look for evidence of ancient life or pre-biotic chemistry. The proposed sensor is directly relevant to NASA's planetary science objectives.

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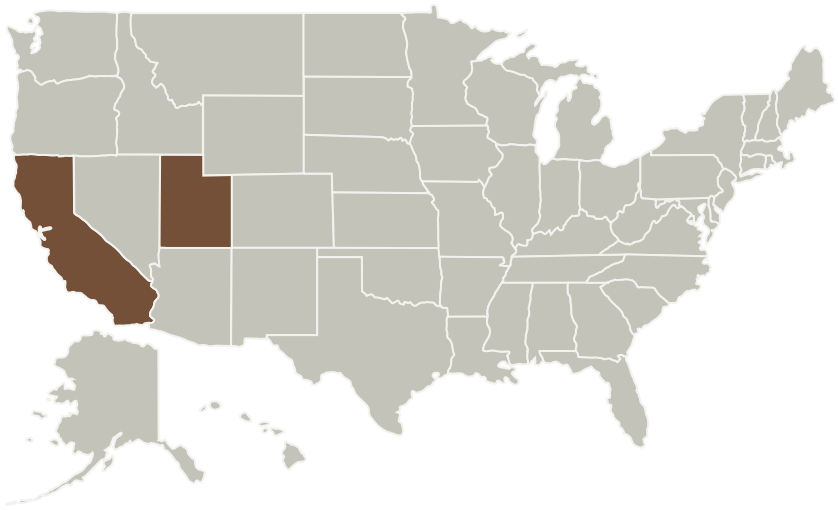
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Southern California(USC)	Lead Organization	Academia	Los Angeles, California
University of Utah	Supporting Organization	Academia	Salt Lake City, Utah
Utah State University(USU)	Supporting Organization	Academia Alaska Native and Native Hawaiian Serving Institutions (ANNH)	Logan, Utah

Primary U.S. Work Locations	
California	Utah

Project Transitions

July 2015: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Southern California (USC)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

Eric A Eberly

Principal Investigator:

Joseph J Wang

Co-Investigators:

Swomitra K Mohanty
Mano Misra
Tatjana Jevremovic

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June 2016: Closed out

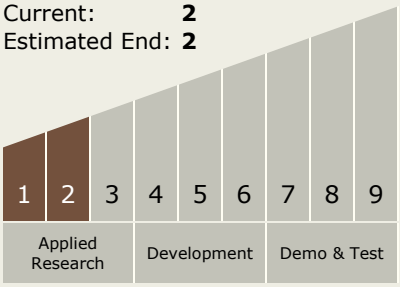
Closeout Summary: This report provides a summary of the work performed under NIAC Phase I award NNx15AL86G entitled CubeSat with Nanostructured Sensing Instrumentation for Planetary Exploration. The objective of this research is to investigate the feasibility of an innovative, low cost, CubeSat based planetary mission concept for in situ ground truth analysis of small asteroids and comets. The project includes an instrument study and a mission/spacecraft design study. The instrument study concerns with the development of a new TiO2 nanotube sensor with integrated compound semiconductor nanowires to determine surface composition element via neutron activated analysis (NAA). The mission/spacecraft design study concerns with the development of CubeSat based lander to small asteroids and comets. The Phase I study suggests that our concept is feasible and could provide significant benefit to NASA's future planetary missions. This research was carried out at the University of Southern California and the University of Utah.

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.3 Thermal Protection Components and Systems
    - TX14.3.4 Thermal Protection System Testing

Target Destinations

The Sun, Outside the Solar System